

# Two-dimensional photoelectron angular distribution from Cu 3d orbitals: Atomic orbital analysis and atomic stereophotography

F. Matsui<sup>1</sup>

<sup>1</sup>Materials Science, Nara Institute of Science and Technology (NAIST), Ikoma, Nara, Japan

Two-dimensional photoelectron angular distribution (PEAD) provide us fruitful information on the electronic and atomic structure of solid surface. Here we report the atomic orbital and atomic structure analyses of Cu(001) surface using linearly and circularly polarized lights, respectively. Display-type spherical mirror analyzer [1] is essential for these studies.

Two-dimensional ultraviolet photoelectron spectroscopy is a powerful method which gives direct access not only to the entire structure of valence band dispersion but also to the atomic orbital conformations composing each band [2]. Three-dimensional structure of Cu Fermi surface and valence band were measured and visualized for the first time by stacking a series of photoelectron angular distribution (PEAD) patterns with different photon and photoelectron kinetic energies. PEAD patterns from the Cu(001) surface were obtained using a linearly polarized VUV light. Example of PEAD patterns of Cu 3d band are shown in Fig. 1(a) and (b).

The azimuthal shifts of forward focusing peaks in PEAD pattern obtained by left and right helicity light are found to be the same as the parallax in stereo-view [3]. Taking advantage of this phenomenon of circularly-polarized light PEAD, one can realize a stereoscope. Figure 2(a) are examples of stereograph of Cu(001) substrate taken at kinetic energy of 265 eV. Three dimensional fcc structure as shown in Fig. 2(b) is clearly observed.

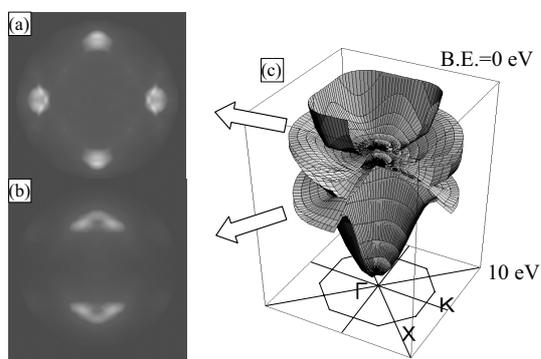


FIG. 1: PEAD patterns of Cu 3d band at binding energy of (a) 2 eV and (b) 4 eV excited by linearly polarized light (45 eV). Three-dimensional valence band dispersion of Cu is shown in (c).

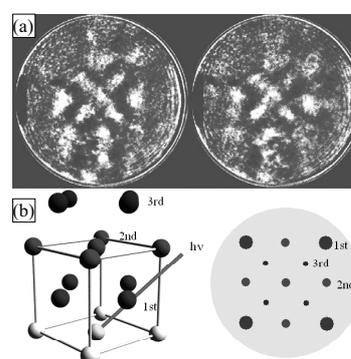


FIG. 2: (a) Stereophotograph of Cu crystal taken at photon energy of 507 eV and (b) a three-dimensional fcc arrangement of atoms in Cu(001) crystal.

**References** [1] H. Daimon, *Rev. Sci. Instrum.*, **59** (1988) 545. [2] F. Matsui, *et al.*, *Appl. Phys. Lett.*, **81** (2002) 2556. [3] H. Daimon, *Phys. Rev. Lett.*, **86** (2001) 2034.